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CHROMOSOME NUMBERS OF AUSTRALIAN SPECIES OF *IPOMOEA* L. (CONVOLVULACEAE)

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Summary

Somatic chromosome counts are reported on 23 species of *Ipomoea* L. found in Australia. The majority are diploids of the basic number x = 15 (2n = 30), but three exhibit tetraploidy (2n = 60), namely *I. plebeia* R. Br., *I. lonchophylla* J. Black and *I. racemigera* F. Muell. These results are discussed in comparison with the cytology of other *Ipomoea* species in the world, endemism of Australian species and the possibility of parallel but limited polyploidy as one product of geographically separate evolution in the genus.

Introduction

In the 'Chromosome Atlas of Flowering Plants', Darling and Wylie (1955, p. 308) confidently assigned the basic number of 15 to the genus *Ipomoea* L., with the majority of species having a somatic number of 30. Diploids were recorded in both Old and New World species, but two American species, shown to have 2n numbers of 60 (*I. ramouri* sic, properly *I. ramoni*) and 90 (*I. batatas*, the cultivated sweet potato), suggested a polyploid series in the genus. Subsequent cytological studies in American species confirmed both the basic chromosome number and the incidence of polyploidy in *Ipomoea* (Ting *et al.* 1957; Nishiyama *et al.* 1964; Nishiyama & Teramura 1962). Jones (1964, 1968) enlarged the geographic representation of species by reporting chromosome counts for species from Egypt, Iran, India and China, without extending the known polyploidy in *Ipomoea* beyond American species, of which a further two wild representatives *I. tiliacea* (Willd.) Choisy and *I. arborescens* (Kunth) G. Don are shown to be tetraploids. As Jones (1968) explained, the inconsistency of reports of earlier chromosome counts of these two species may have been due to misidentification of unfamiliar plants, although the possibility of autopolyploidy remains. However, questionable identification has plagued cytological work in the genus in the past, which brings Australian species into consideration.

I. gracilis R. Br. is an endemic of Australia (Bentham 1869; Austin 1978), yet it is cited in the literature as a tetraploid based on collections from Cuba (Ting *et al.* 1957) and Mexico (Nishiyama *et al.* 1961). Taxonomic confusion may have resulted from the assignment of synonyms, *I. fastigiata* Sweet and *I. denticulata* Choisy, by Ting, Nishiyama and their respective co-authors. According to the revision of van Ooststroom (1954), *I. denticulata* is synonymous with *I. gracilis*, though Bentham (1869) kept the relevant taxa separate in Australia. Johnson (pers. comm.) suggests that *I. tiliacea*, collected as a single specimen in Australia by L.J. Brass from the Daintree River region in 1932, may be *I. fastigiata.* Austin (1991) has at least clarified the situation with regard to earlier Old World recordings of '*I. gracilis*'; his taxonomic analysis indicates that the proper identification for these non-Australian plants is *I. littoralis.*

In more general terms, interest in Australian *Ipomoea* has quickened with the discovery of 'new' endemic species, and the realization that the ethnohistoric records of 'bush potato' of the arid zone, supported by the contemporary observations of anthropologists (Meggitt 1957; O'Connell *et al.* 1983), indicated important food sources of the prehistoric Aborigine. Golson's comprehensive survey (1971) of Aboriginal food plants included *Ipomoea* species, many of which are reported on in this paper. Indeed the present account of the first cytological survey of the genus in Australia arose from two Australian National University seminars in 1984 and 1986, when biologists and anthropologists came together under the rather enigmatic theme, 'Australia as bystander in the development of Pacific agriculture.'

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Materials and Methods

A study of the desert *Ipomoea* species began in 1982 on the tuber-bearing woody shrub, *I. costata* F. Muell. most commonly found in the central desert of Australia. Its distribution has been determined to be in a relatively narrow band of the continent beginning close to the border between the Northern Territory and Queensland at latitudes 19° and 23°S, and stretching westwards to the Tanami Desert. From there it extends to the Great Sandy Desert where the band of distribution moves northward, narrowing to accommodate the southerly foothill areas of the Kimberley Range of Western Australia, thence to the coast of Dampier Land. From there the distribution is coastal reaching a southerly latitude of c. 24°S. This species, described by Bentham (1869), was sampled for this study as seed of individual plants from localities throughout its wide distribution in the Northern Territory and Western Australia.

Early in the fieldwork, Peter Latz pointed out another *Ipomoea* species in the Northern Territory, a tuber-bearing large herb used by the Aborigines of the region around Tea Tree and Barrow Creek Stations near the Stuart Highway at latitude of c. 22°S. The field description of this species was recorded by Soos and Latz (1987) while taxonomically it was described and named *I. polpha* by Johnson (1986) when naming three other 'new' species including another herbaceous tuber-bearer, *I. argillicola.* The latter species was recorded as being found largely in Queensland, but no information on Aboriginal exploitation was given. The type specimen for *I. polpha* is from the Cook Pastoral District in Queensland and Johnson (1986, p. 220) cautioned that because of their diversity, further study of the central desert specimens 'may warrant the erection of a taxon of subspecific rank' for them.

Seeds from the desert *I. polpha* were collected in the field, and seeds of one of the Queensland populations of that species and of *I. argillicola* were provided by Dr Robert Johnson. Another recently described species (George 1967), the woody shrub *I. yardiensis*, was collected in Karratha, Western Australia where it was growing as a horticultural novelty in institutional gardens. Its natural distribution is limited to the Exmouth Peninsula, Western Australia. The function of the small tuberous growths of this near-endangered species in Aboriginal life is unknown.

Our earliest chromosome counts on mitotic cells from root tips of germinating seeds of *I. costata* and *I. polpha* yielded a 2n number of 30, the basic diploid number for the genus. With the number of endemic species present in Australia, it was decided, in consultation with Dr Johnson, that we should enlarge the cytological aspect of our *Ipomoea* study to include examination of available seed of other species that are included in Johnson's forthcoming revision of the genus in Australia. **Table 1,** listing the material used in this study, is divided into three parts on criteria of endemism as defined by Johnson (pers. comm.): **part a** includes comparatively recent introductions, probably as ornamental plants; **part b**, tropical taxa whose distribution extends to Australia, and are regarded as native but not endemic; and **part c**, the endemic species.

Root tips for chromosome counting were obtained from potted plants grown from seed in a glasshouse at Australian National University, or directly from seeds germinated after puncturing to allow water permeation of the often hard testa. Excised tips were soaked in a 0.2% solution of colchicine for 3 hours, then fixed with Carnoy's fluid (3:1 absolute ethyl alcohol: glacial acetic acid) in which they could be stored at 4°C. For

Table 1a. Somatic chromosome numbers of *Ipomoea* species introduced into Australia

Species	Queensland Herbarium Voucher No.	Collection area	Chromosome Number 2n
I. alba L.	AQ345299	Brisbane, Qld	30
I. hederacea Jacq.	AQ450061	Brisbane, Qld	30
I. quamoclit L.	AQ378850	Brisbane, Qld	30
I. triloba L.	AQ370556	Cape York, Qld	30

Table 1b. Somatic chromosome numbers of *Ipomoea* species native to but not endemic in Australia

Species	Queensland Herbarium Voucher No.	Collection area	Chromosome Number 2n
I. aculeata Blume	AQ292438	Yeppoon, Qld	30
I. coptica Roth ex Roemer & Schultes	AQ377824	Georgetown, Qld	30
I. diversifolia R. Br.	AQ370534	Cape York, Qld	30
I. mauritania B. Jacq. (*I. digitata*)	AQ343343	Cape York, Qld	30
I. eriocarpa R. Br.	AQ264666	Dingo Beach, Qld	30
I. pes-caprae subsp. *brasiliensis* (L.) van Oostr.	AQ442970	Ellis Beach, Qld	30
I. plebeia R. Br.	AQ370589	Mt. Mulgrave, Qld	60
I. polymorpha Roemer & Schultes	AQ411953	Rockhampton, Qld	30
I. macrantha Roemer & Schultes (*I. violacea*)	AQ343338	Brisbane, Qld	30

Table 1c. Somatic chromosome numbers of *Ipomoea* species endemic in Australia

Species	Queensland Herbarium Voucher No.	Collection area	Chromosome Number 2n
I. argillicola R.W. Johnson	AQ78848	Longreach, Qld	30
I. brassii C. White	AQ443652	Doomadgee, Qld	30
I. costata F. Muell. ex Benth.	(ANU)*	NT, WA	30
I. diamantinensis J. Black in Eardley	J46**	Monkira, Qld	30
I. gracilis R. Br.	AQ378908	Laura, Qld	30
I. lonchophylla J. Black	J67**	Boggabilla, NSW	60
I. muelleri Benth.	AQ443655	James Range, NT	30
I. polpha R.W. Johnson	(ANU)*	Tea Tree, NT	30
I. racemigera F. Muell.	AQ378844	Qld	60
I. yardiensis A.S. George & Tate	(ANU)*	Karratha, WA	30

* (ANU) = seed collected from individual plants. Number of plants represented in chromosome counts: *I. costata*, 16; *I. polpha*, 4; *I. yardiensis*, 2. Seed collection deposited in Department of Prehistory, RSPacS, Australian National University.

** Seed collection numbers, Queensland Herbarium.

counting, chromosome spreads were prepared by the Fuelgen squash technique. Root tips were removed from the fixative, hydrolysed at 60°C for 4–5 minutes in 0.1m hydrochloric acid, then stained with Fuelgen solution for up to 60 minutes. The tips were then macerated individually on slides in 45% acetic acid and counterstained with lacto-propionic orcein for about 5 minutes under coverslips. After warming briefly, preparation were tapped with a glass rod to finally spread material, then squashed for microscopic inspection and counting of chromosomes. Photographs were taken of appropriate chromosome spreads at ×1000 magnification.

It should be mentioned that attempts were made to fix flower-bud material in the field for counts of meiotic chromosomes. Collection at different times of the day, concentrating on the pre-dawn period as Ting and Kehr (1953) have reported as effective for obtaining dividing pollen mother cells in *I. batatas*, was unsuccessful. We can only attribute this to the less than ideal conditions of storage and transport of material collected in our field work.

Results

In Australia, all four introduced species of pantropic distribution are shown to be diploids with 2n = 30 (**Table 1a**). According to van Ooststroom (1954), *I. alba* and *I. triloba* are of tropical American origin, while *I. quamoclit* 'runs wild' in Malaysia. Bentham (1869) states that the latter species 'is believed to be of East Indian origin' but is now, following O'Donell (1959), also considered to be American. The widespread North American *I. hederacea* considered by some to be conspecific with the Malaysian *I. nil* is subject to taxonomic dispute (van Ooststroom 1954, p. 465). Bearing this confusion in mind, our somatic chromosome count of 2n = 30 for *I. hederacea* conforms with the result of Jones (1964, p. 217) for '*I. nil* (syn *I. hederacea* Jacq.)', and his review of previous chromosome counts in the species. Although Austin (1986) leans towards synonymy with regard to these two 'species' he nevertheless, on mainly historical grounds, maintains nomenclatural separation. Johnson (pers. comm.) accepts them as two separate entities, noting that *I. nil*, as a very widespread taxon in Australia (but not included in this study), should not be confused with the sample of *I. hederacea* cytologically examined by us. The diploid counts we obtained for *I. triloba* and *I. alba* conform with those made by Jones (1968) as does the determination of *I. hederacea* with the n = 15 number by S.P. Vij, S. Singh and V.P. Sachdeva (Love 1974).

Table 1b lists the chromosome numbers of nine species native, but not regarded as endemic to Australia. While most are diploid (2n = 30), *I. plebeia* is the lone tetraploid in the group with 2n = 60. Most of these species are found in tropical island Southeast Asia or Malaysia according to van Ooststroom (1954), with *I. diversifolia* extending to India, *I. coptica*, *I. eriocarpa* and *I. polymorpha* to Africa, with *I. macrantha* and *I. mauritania* being pantropic. While *I. pes-caprae* is pantropic in its distribution, 'the common subspecies throughout Malaysia' is subsp. *brasiliensis* (van Ooststroom 1954, p. 476). The chromosome count for this form in Australia conforms with those reported by Jones (1964) for the species and earlier cytological work on unspecified American subspecies. If the synonymies indicated in **Table 1b** are proved to be firm, there is agreement with Jones (*op. cit.*) in the diploid chromosome number determinations for *I. mauritania* (= *I. digitata*) and *I. macrantha* (= *I. violacea*). As far as can be ascertained, these are the first recordings of chromosome numbers for *I. aculeata* and the tetraploid *I. plebeia.*

The majority of the ten species endemic in Australia are diploids with somatic chromosome number 2n = 30, although two, *I. lonchophylla* and *I. racemigera*, prove to be tetraploids (**Table 1c**). Mitotic metaphase cells of four of the species are shown in **Figure 1.** It can be seen that the three tuber-bearing species, *I. argillicola*, *I. costata* and *I. polpha*, have somatic complements of 30 chromosomes, as have *I. muelleri* and the Western Australian *I. yardiensis.* Counts from seedling root tips of Western Australian representative plants of *I. costata* were consistent with counts from central Australian plants. It was unfortunate that the same comparison could not be made between the central Australian *I. polpha* plants and representatives of the Queensland populations of the same species; the seed sample from the Queensland Herbarium failed to germinate.

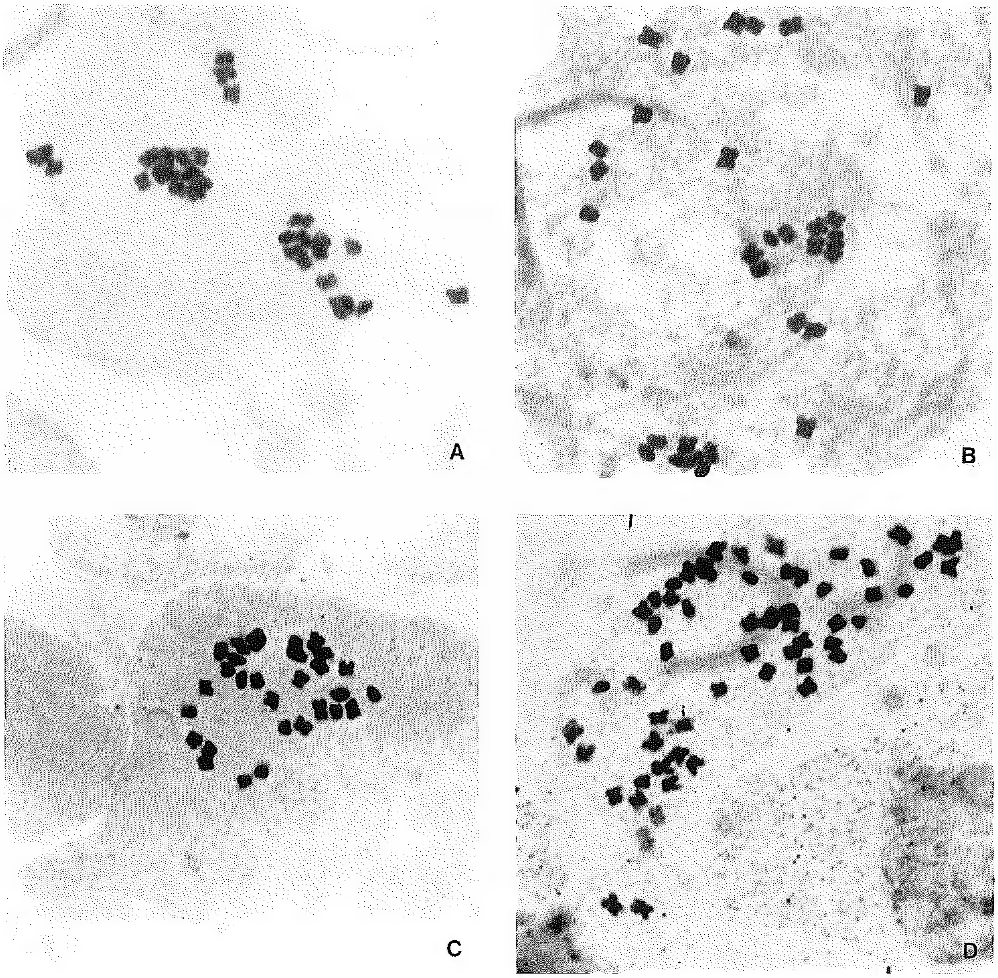

Fig. 1. The chromosomes at mitotic metaphase in root tip cells of four Australian endemic species of *Ipomoea*: 2n = 30 in A, *I. costata*, B, *I. polpha* and C, *I. yardiensis*; 2n = 60 in D, *I. lonchophylla*. (Preparations and microphotographs by P.M. Gaffey).

Discussion

The basis chromosome number of x = 15 for the genus *Ipomoea* is confirmed for the Australian species, whether native or naturalised. The variation in somatic chromosome number in the endemic species suggest that polyploidy played a role in the evolution of species in Australia. However, Johnson (pers. comm.) points out that the two endemic Australian tetraploid species, *I. lonchophylla* and *I. racemigera* have taxonomic affinity with *I. plebeia* (the only other polyploid found in the Australian collection) and all three species belong to the section Calycantheum of the genus (van Ooststroom 1954). Thus Johnson (pers. comm.) opines that polyploidy in the two Australian species was likely derived from *I. plebeia*, of wide distribution in insular southeast Asia.

The American polyploids occur within two of the seven sections (as recognised by van Ooststroom 1954) of *Ipomoea* other than *Calycantheum*: the tetraploid *I. ramoni* and *I. tiliacea*, of the section *Batatas*; the tetraploid *I. arborescens* of the section *Leiocalyx*. From available evidence, only in America did any species attain hexaploidy – in the cultivated sweet potato *I. batatas* of the section *Batatas* and allied weed species (Jones 1967; Yen 1974).

Jones (1964, 1968) indicates diploid forms have been found in *I. ramoni*, *I. tiliacea* and *I. arborescens*. Such might be the case in the Australian species assigned as tetraploids in this study if cytological analysis is extended to further plant collection. Of particular interest would be the chromosome counts of *I. plebeia*, with its distribution in Queensland and the southern Indonesian islands, for the area may be determined in which polyploidy occurred independently in the genus beyond the New World.

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